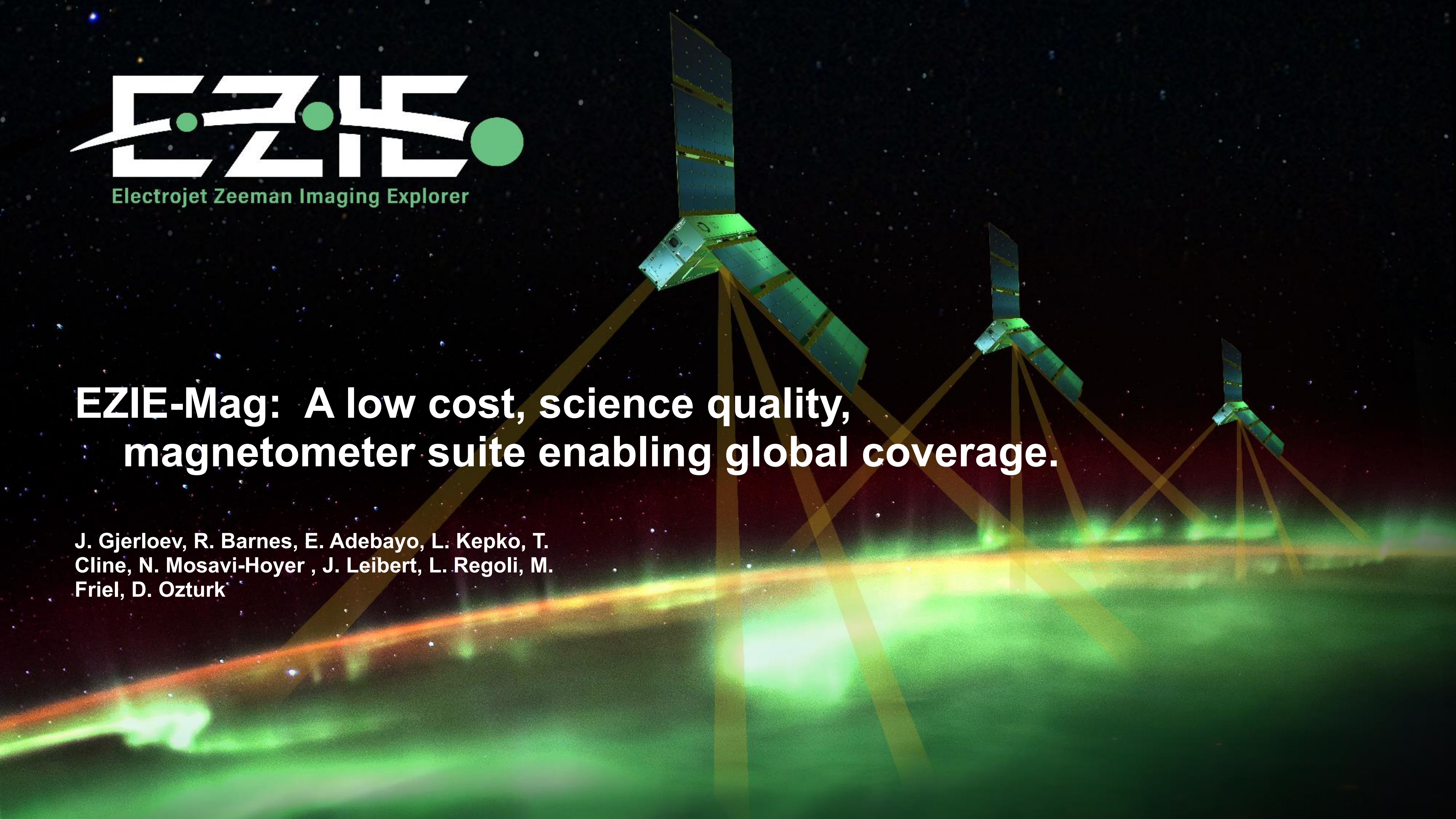


EZIE

Electrojet Zeeman Imaging Explorer

EZIE-Mag: A low cost, science quality, magnetometer suite enabling global coverage.

J. Gjerloev, R. Barnes, E. Adebayo, L. Kepko, T. Cline, N. Mosavi-Hoyer , J. Leibert, L. Regoli, M. Friel, D. Ozturk

NASA EZIE mission

– at a glance

What?

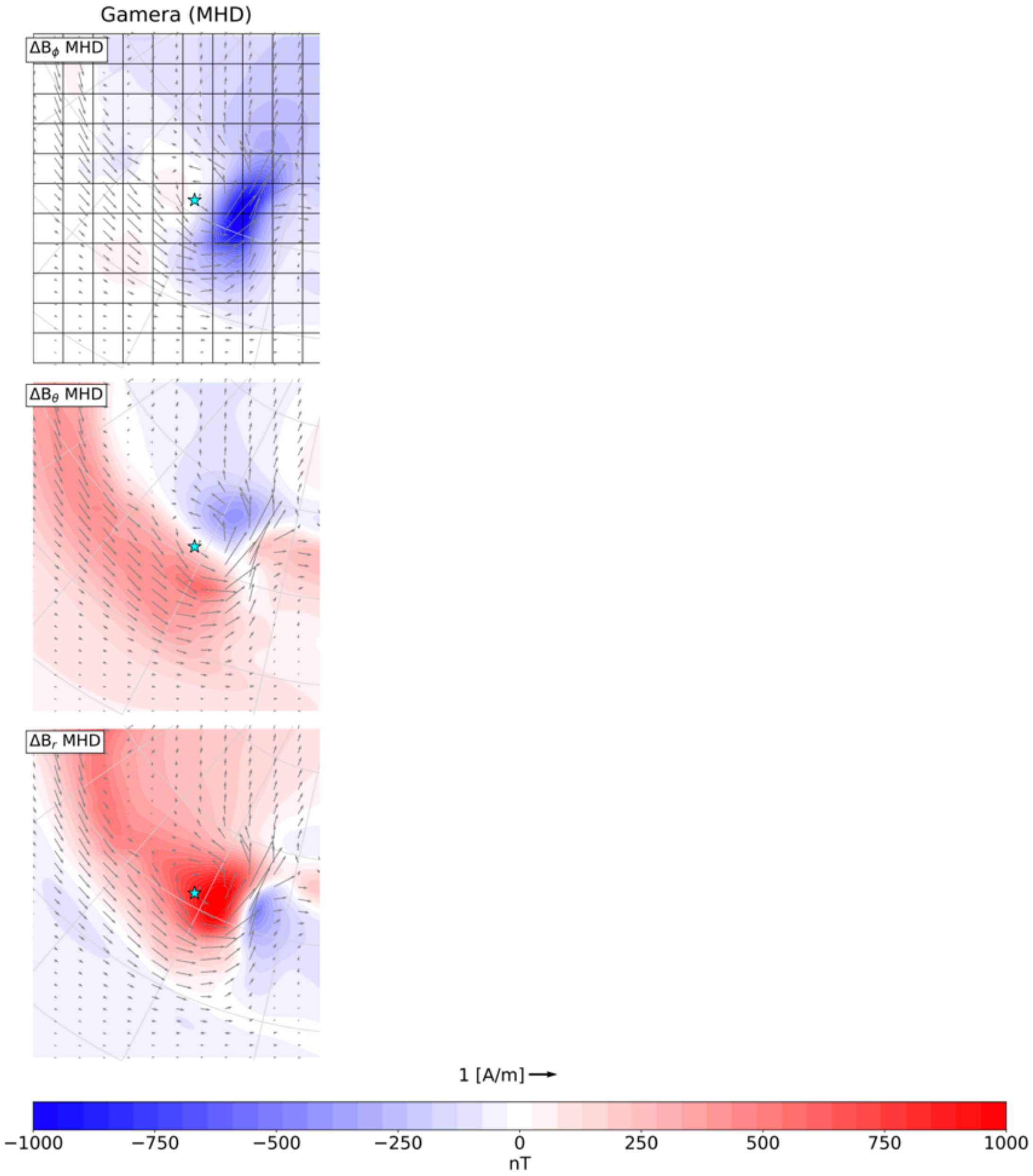
- EZIE will resolve decades-old and much-debated science controversies by revealing the structure and evolution of the electrojets.

Why?

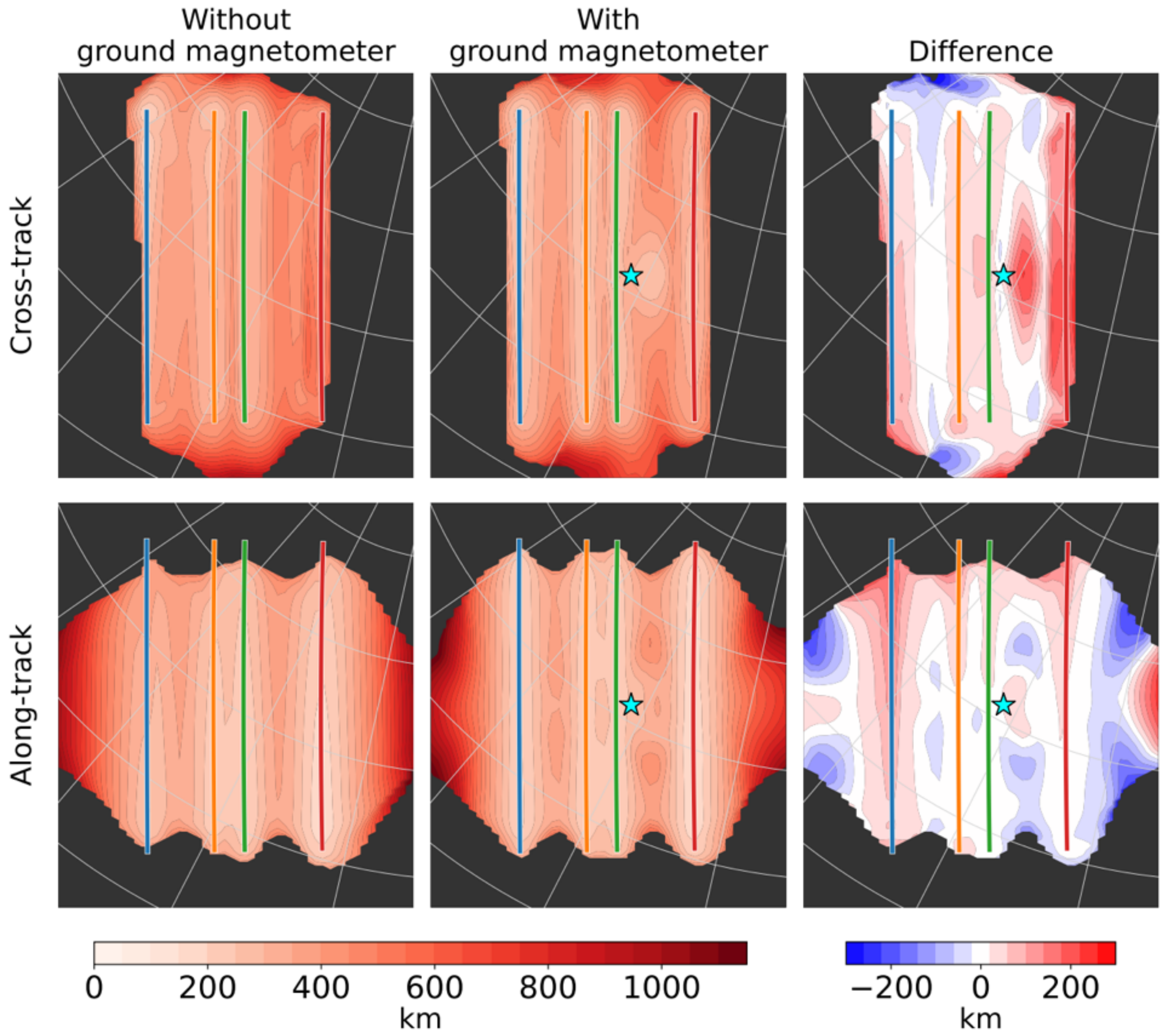
- EZIE science is universal for how magnetized bodies interact with space.
- The electrojets are a key space-weather component.

Why do we need more magnetometers?

- NASA EZIE solutions are better constrained

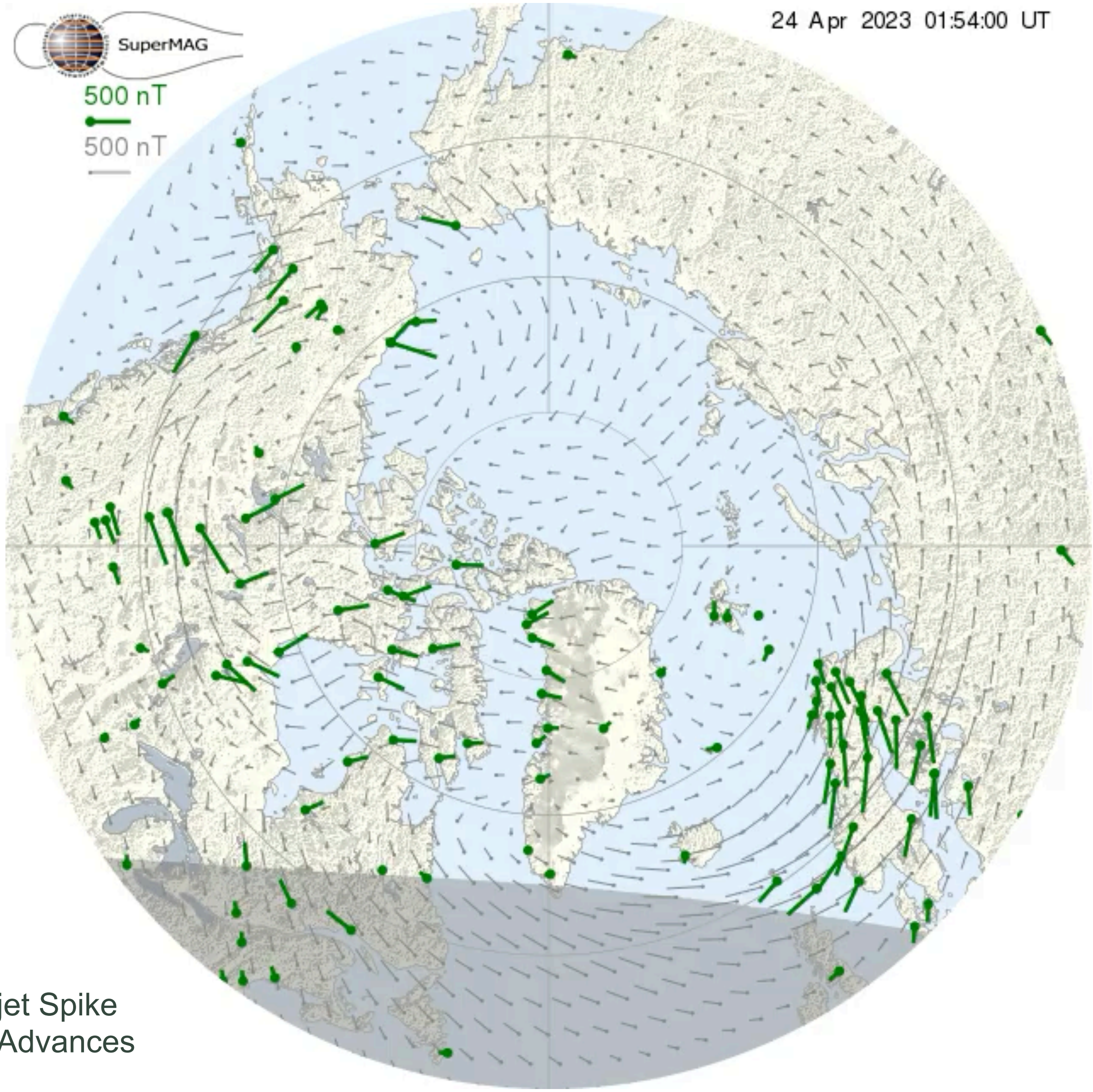


Madelaire et al., [2023]



Why do we need more magnetometers?

- Space weather is local and global

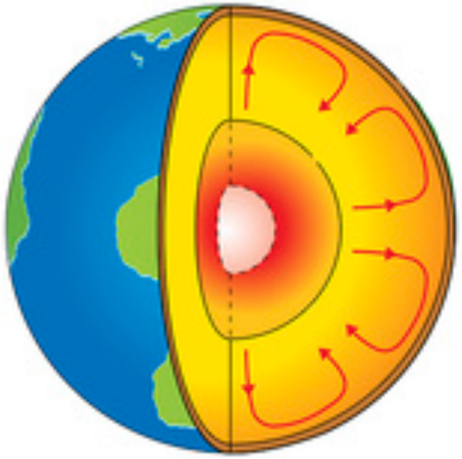

SuperMAG
500 nT
500 nT
24 Apr 2023 01:54:00 UT

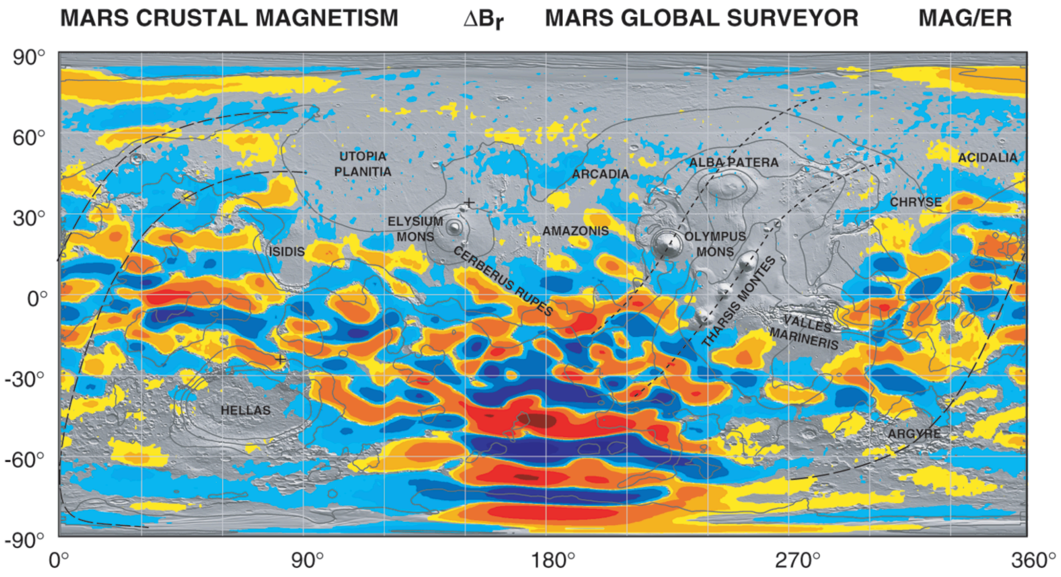
Zou et al., (2023), An Extreme Auroral Electrojet Spike during 2023 April 24th Storm, accepted, AGU Advances

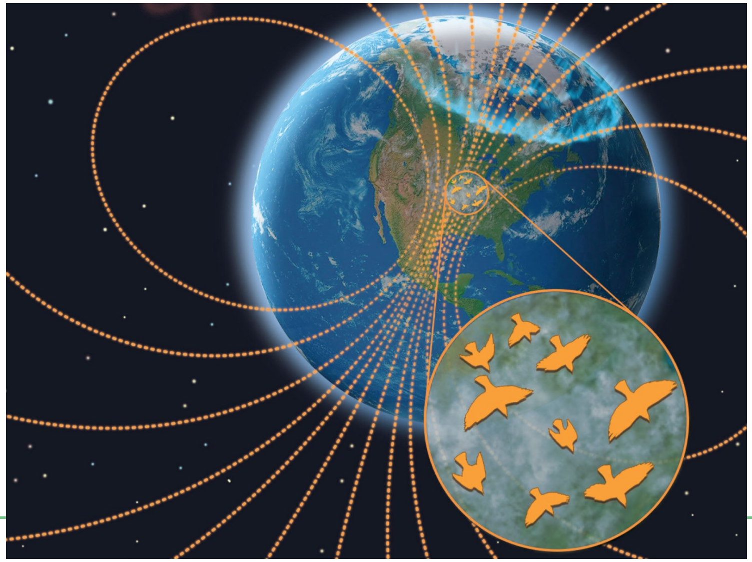
Why do we need more magnetometers?

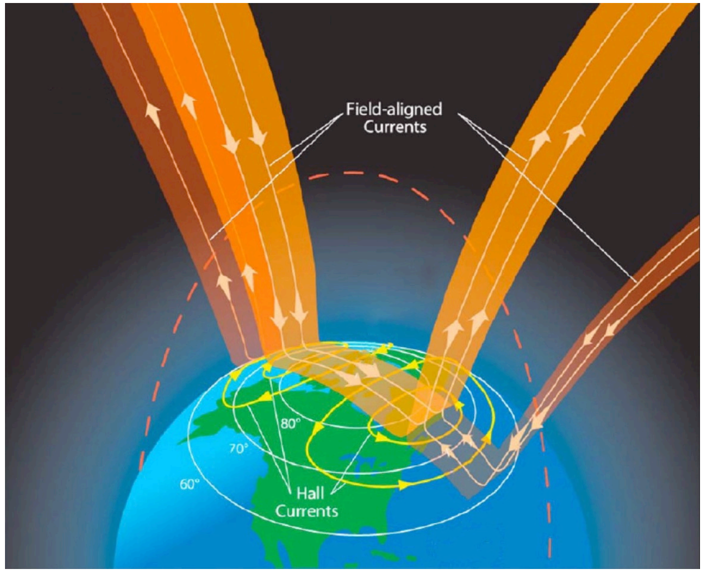
- just a brief note

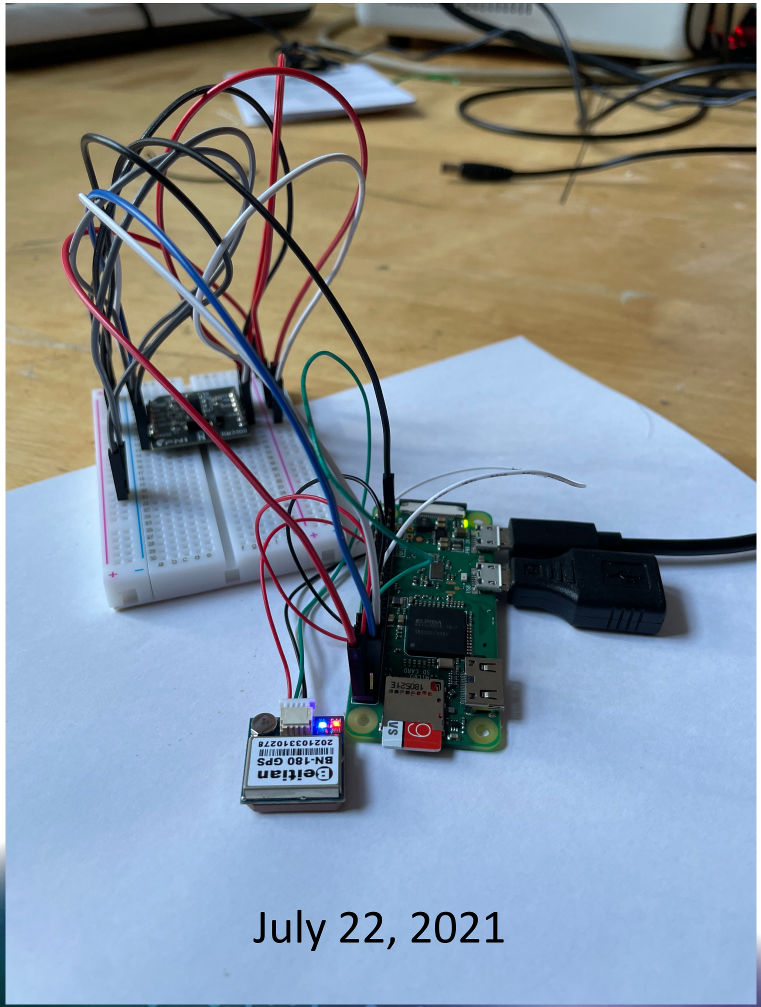
- Navigation
- Earth-Space interactions
- Geology
- Internal Earth processes
- Animal life



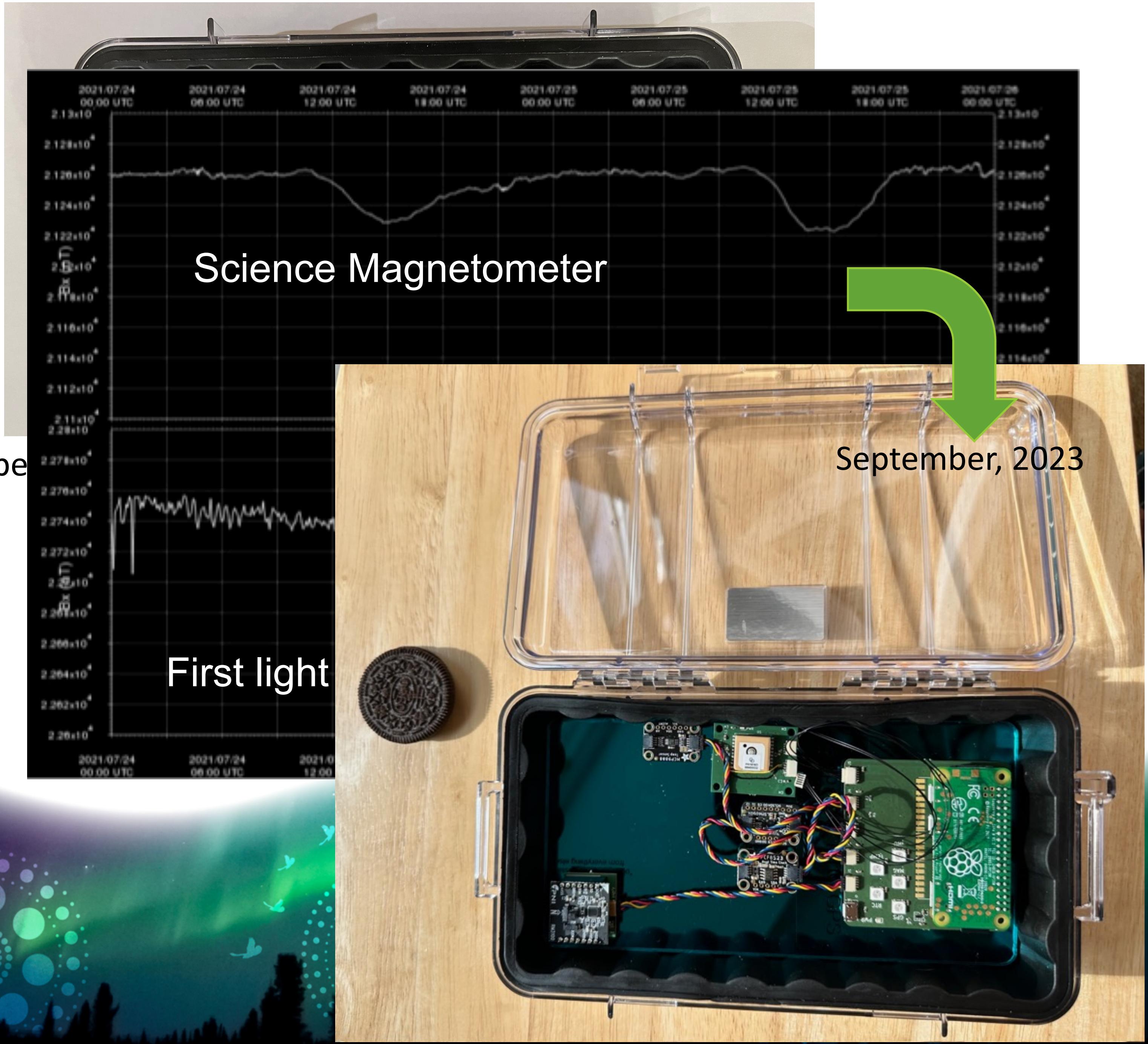

MARS CRUSTAL MAGNETISM
ΔBr
MARS GLOBAL SURVEYOR
MAG/ER
90°
60°
30°
0°
-30°
-60°
-90°
0°
90°
180°
270°
360°
UTOPIA PLANITIA
ARCADIA
ALBA PATERA
ACIDALIA
CHRYSE
ELYSIUM MONS
ISIDIS
AMAZONIS
OLYMPUS MONS
CERBERUS RUPES
THARSIS MONTES
VALLES MARINERIS
HELLAS
ARGYRE




Field-aligned Currents
80°
70°
60°
Hall Currents



July 22, 2021



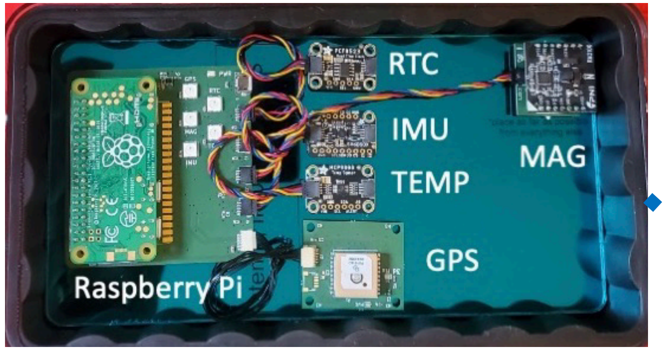
Novembe

Science Magnetometer

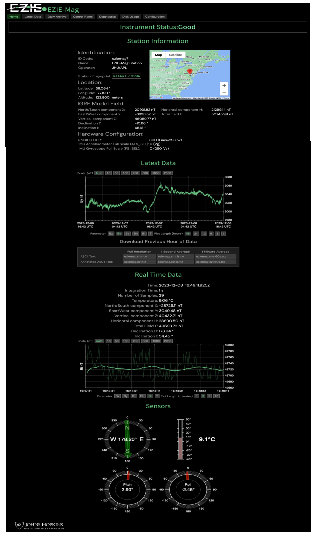
First light

September, 2023

Hardware


RTC
IMU
MAG
TEMP
GPS
Raspberry Pi

Software


EZIE-Mag
Home
Latest Data
Daily Archive
Control Panel
Diagnostics
Disk Usage
Configuration

Instrument Status:Good

Station Information

Identification:
ID Code: eziemag7
Name: EZIE-Mag Station
Operator: JHU/APL
Station Fingerprint: AAAAAIu1PVHA

Location:
Latitude: 39.064 °
Longitude: -77.190 °
Altitude: 123.800 meters

IGRF Model Field:
North/South component X: 20931.82 nT
East/West component Y: -3938.57 nT
Vertical component Z: 46059.77 nT
Declination D: -10.66 °
Inclination I: 65.18 °
Horiontal component H: 21299.14 nT
Total Field F: 50745.99 nT

Hardware Configuration:
RM3100 CCR: 800 (Gain=298.57)
IMU Accelerometer Full Scale (AFS_SEL): 0 (2g)
IMU Gyroscope Full Scale (FS_SEL): 0 (250 °/s)

Latest Data

Scale: (nT) Auto 10 50 100 250 500 1000 2000
By nT
2023-12-06 16:42 UTC
2023-12-07 04:42 UTC
2023-12-07 16:42 UTC
2023-12-08 04:42 UTC
2023-12-08 16:42 UTC
Parameter: Bx By Bz Bh Bt T Plot Length (hours): 48 24 12 6 3 1

Download Previous Hour of Data

	Full Resolution	1 Second Average	1 Minute Average
ASCII Text:	eziemag.smr.txt	eziemag.smr.1s.txt	eziemag.smr.60s.txt
Annotated ASCII Text:	eziemag.ezt.txt	eziemag.ezt.1s.txt	eziemag.ezt.60s.txt

Real Time Data

Time: 2023-12-08T16:49:11.925Z
Integration Time: 1 s
Number of Samples: 39
Temperature: 9.06 °C
North/South component X: -28729.11 nT
East/West component Y: 3049.48 nT
Vertical component Z: 40432.71 nT
Horiontal component H: 28890.50 nT
Total Field F: 49693.72 nT
Declination D: 173.94 °
Inclination I: 54.45 °

Scale: (nT) Auto 10 50 100 250 500 1000 2000
Bt nT
16:47:11
16:47:31
16:47:51
16:48:11
16:48:31
16:48:51
16:49:11
Parameter: Bx By Bz Bh Bt T Plot Length (minutes): 1 2 5 10

Sensors

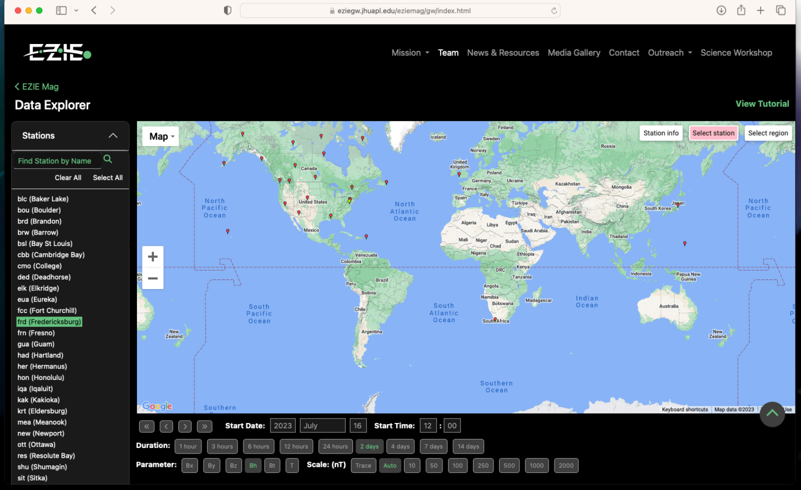
W 178.20° E
9.1°C
Pitch 2.90°
Roll -2.45°
Johns Hopkins Applied Physics Laboratory

EZIE MAG
NASA
Johns Hopkins Applied Physics Laboratory

Post Processing

Measured Field
↓
Temperature Calibration
↓
Rotate to vertical using accelerometer data
↓
Rotate to local magnetic field using magnetometer data
↓
Rotate to geographic reference system using IGRF
↓
Calibrate field using IGRF
↓
Final Field

Website


eziegw.jhuapl.edu/eziemag/gw/index.html
EZIE
Mission
Team
News & Resources
Media Gallery
Contact
Outreach
Science Workshop
EZIE Mag
View Tutorial
Stations
Find Station by Name
Clear All
Select All
Map
Station info
Select station
Select region

Data Explorer

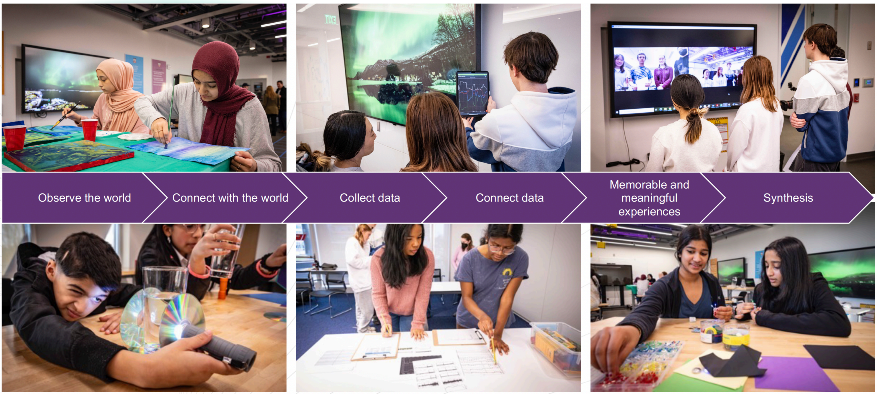
blc (Baker Lake)
bou (Boulder)
brd (Brandon)
brw (Barrow)
bsl (Bay St Louis)
cbb (Cambridge Bay)
cmo (College)
ded (Deadhorse)
elk (Elkridge)
eua (Eureka)
fcc (Fort Churchill)
frd (Fredericksburg)
frn (Fresno)
gua (Guam)
had (Hartland)
her (Hermanus)
hon (Honolulu)
iqa (Iqaluit)
kak (Kakioka)
krt (Eldersburg)
mea (Meanook)
new (Newport)
ott (Ottawa)
res (Resolute Bay)
shu (Shumagin)
sit (Sitka)

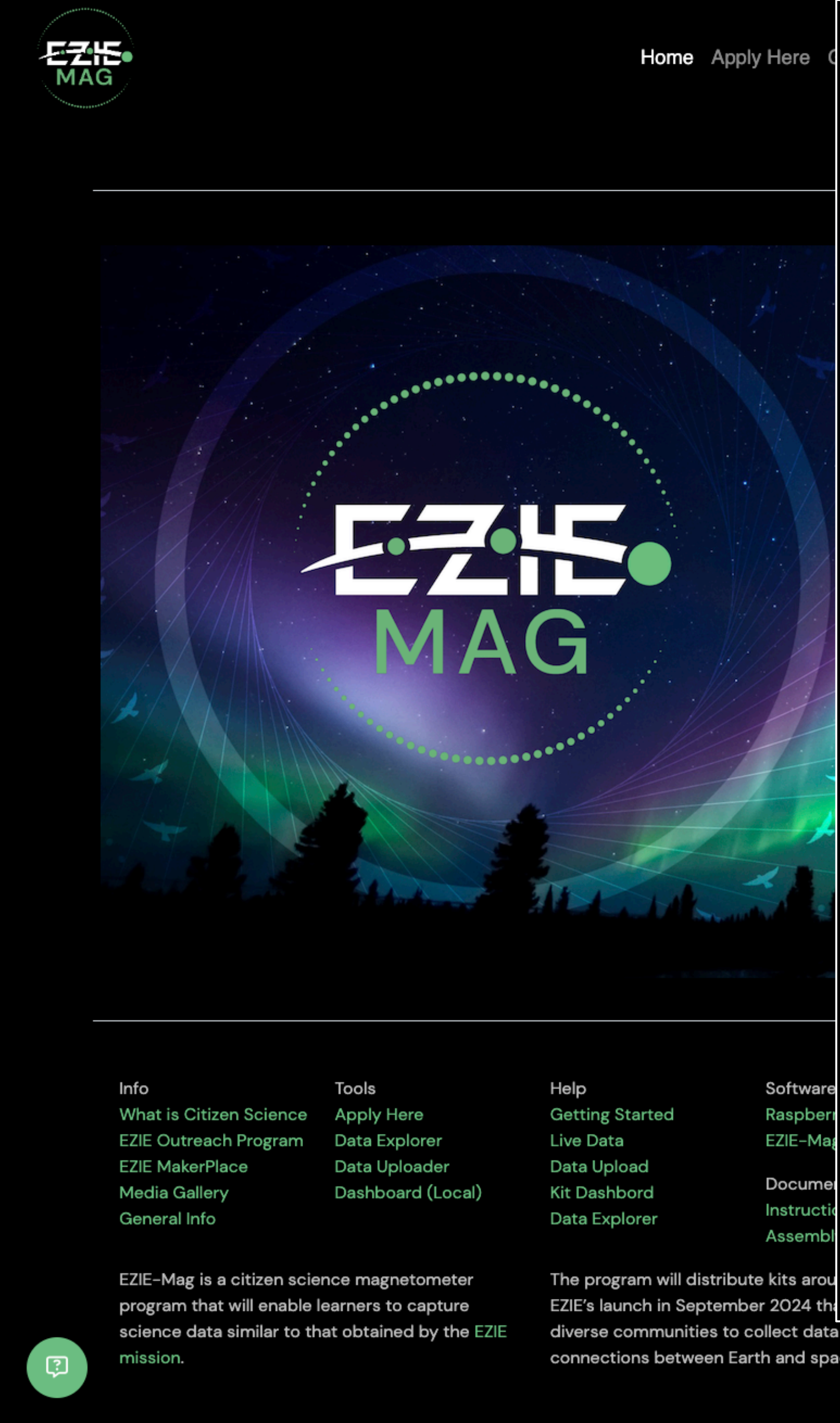
Start Date: 2023 July 16 Start Time: 12 : 00

Duration: 1 hour 3 hours 6 hours 12 hours 24 hours 2 days 4 days 7 days 14 days

Parameter: Bx By Bz Bh Bt T Scale: (nT) Trace Auto 10 50 100 250 500 1000 2000

Outreach


Observe the world
Connect with the world
Collect data
Connect data
Memorable and meaningful experiences
Synthesis



Home
Apply Here
EZIE MAG

Info
What is Citizen Science
EZIE Outreach Program
EZIE MakerPlace
Media Gallery
General Info

Tools
Apply Here
Data Explorer
Data Uploader
Dashboard (Local)

Help
Getting Started
Live Data
Data Upload
Kit Dashbord
Data Explorer

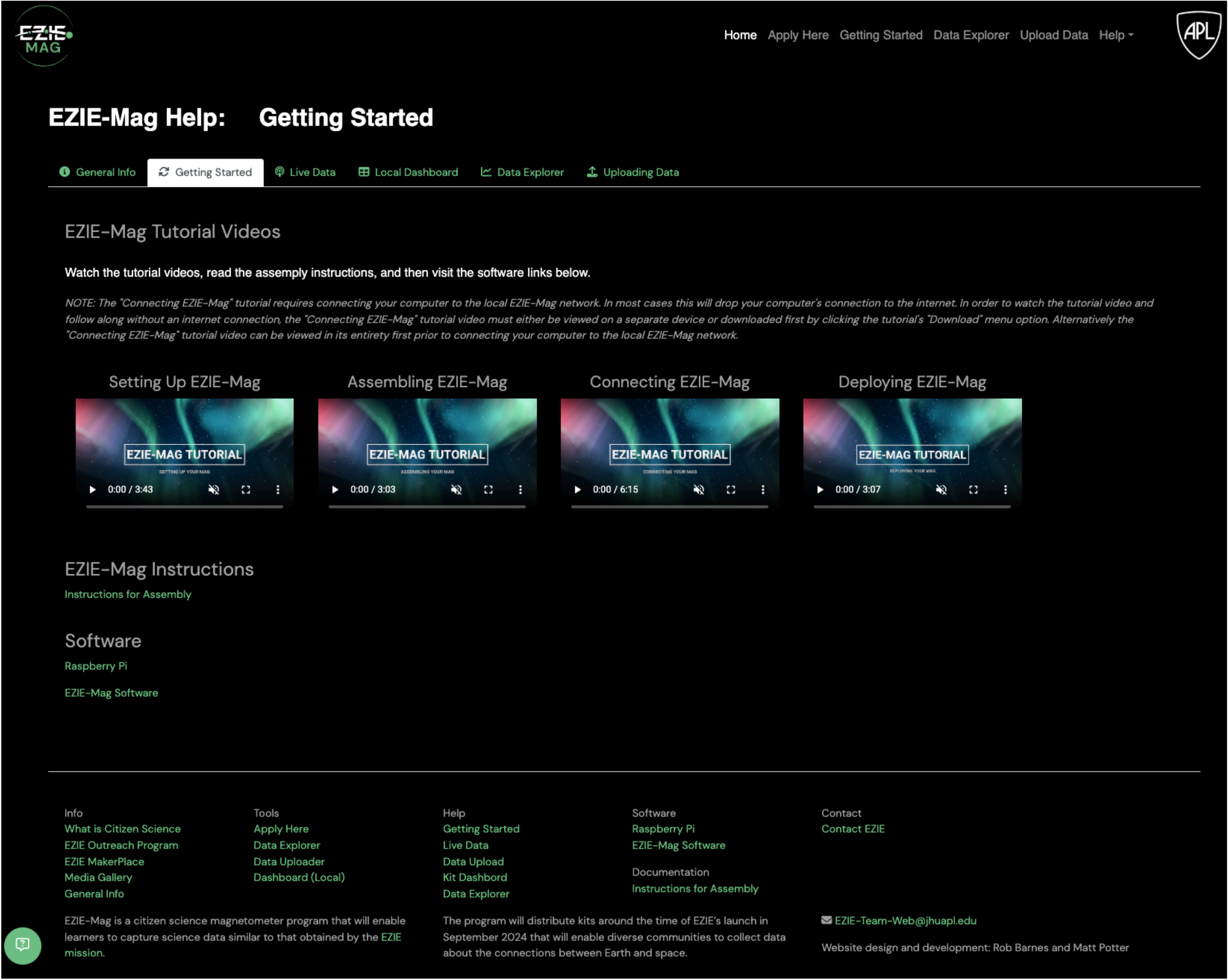
Software
Raspberr
EZIE-Ma

Docume
Instructi
Assembl

EZIE-Mag is a citizen science magnetometer program that will enable learners to capture science data similar to that obtained by the EZIE mission.

The program will distribute kits arou
EZIE's launch in September 2024 th
diverse communities to collect data about the
connections between Earth and space.

Website design and development: Rob Barnes and
Matt Potter



EZIE MAG
Home
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Data Explorer
Upload Data
Help
APL

EZIE-Mag Help: Getting Started

General Info
Getting Started
Live Data
Local Dashboard
Data Explorer
Uploading Data

EZIE-Mag Tutorial Videos

Watch the tutorial videos, read the assemply instructions, and then visit the software links below.

NOTE: The "Connecting EZIE-Mag" tutorial requires connecting your computer to the local EZIE-Mag network. In most cases this will drop your computer's connection to the internet. In order to watch the tutorial video and follow along without an internet connection, the "Connecting EZIE-Mag" tutorial video must either be viewed on a separate device or downloaded first by clicking the tutorial's "Download" menu option. Alternatively the "Connecting EZIE-Mag" tutorial video can be viewed in its entirety first prior to connecting your computer to the local EZIE-Mag network.

Setting Up EZIE-Mag

EZIE-MAG TUTORIAL
0:00 / 3:43

Assembling EZIE-Mag

EZIE-MAG TUTORIAL
0:00 / 3:03

Connecting EZIE-Mag

EZIE-MAG TUTORIAL
0:00 / 6:15

Deploying EZIE-Mag

EZIE-MAG TUTORIAL
0:00 / 3:07

EZIE-Mag Instructions

Instructions for Assembly

Software

Raspberry Pi

EZIE-Mag Software

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Data Explorer

Software
Raspberry Pi
EZIE-Mag Software

Documentation
Instructions for Assembly

Contact
Contact EZIE

EZIE-Mag is a citizen science magnetometer program that will enable learners to capture science data similar to that obtained by the EZIE mission.

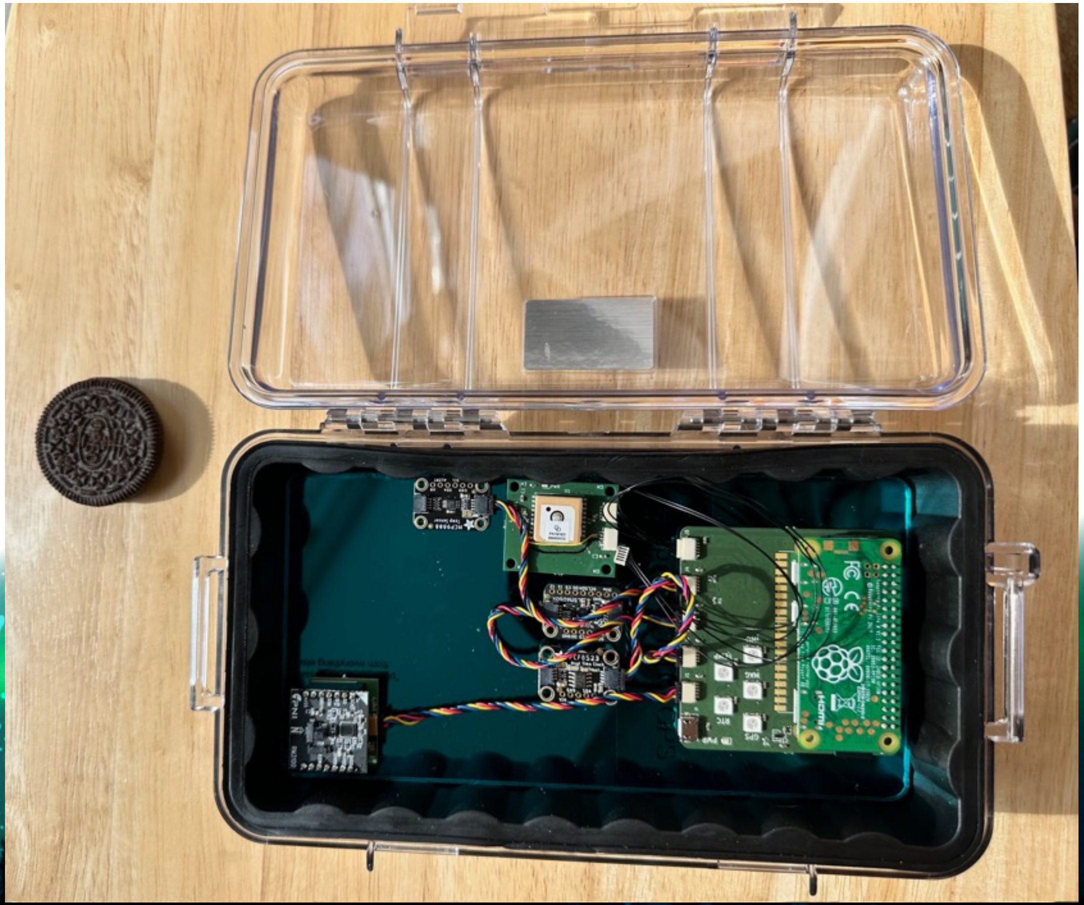
The program will distribute kits around the time of EZIE's launch in September 2024 that will enable diverse communities to collect data about the connections between Earth and space.

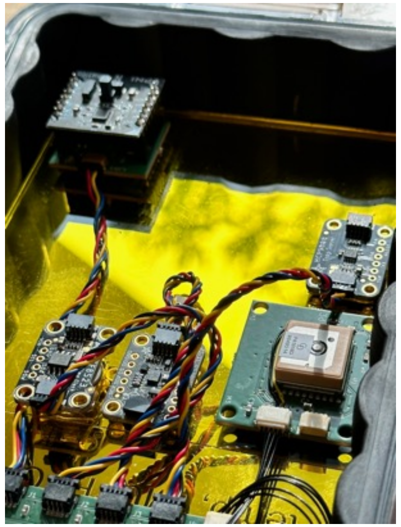
✉ EZIE-Team-Web@jhuapl.edu

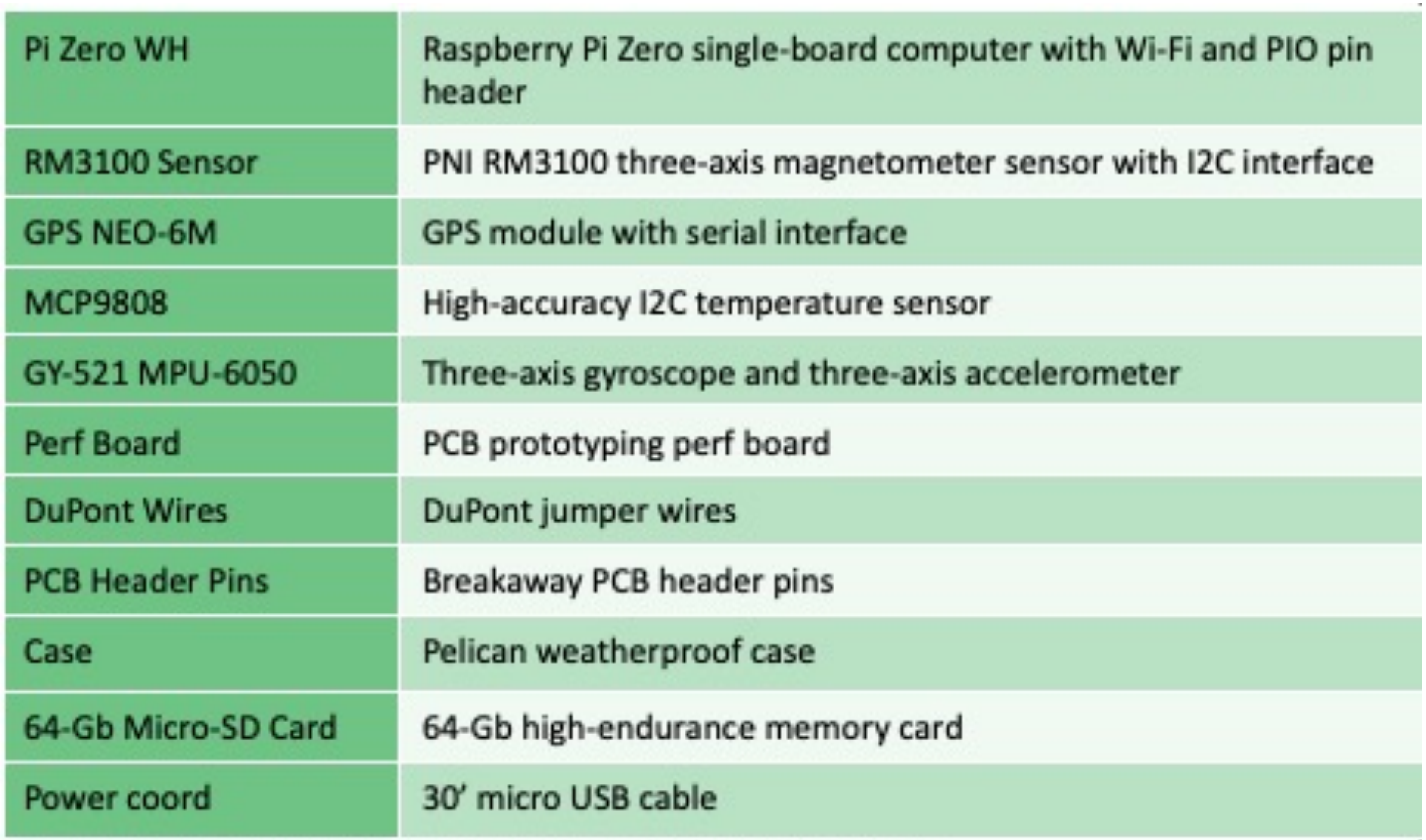
Website design and development: Rob Barnes and Matt Potter

EZIE
MAG
NASA
Johns Hopkins

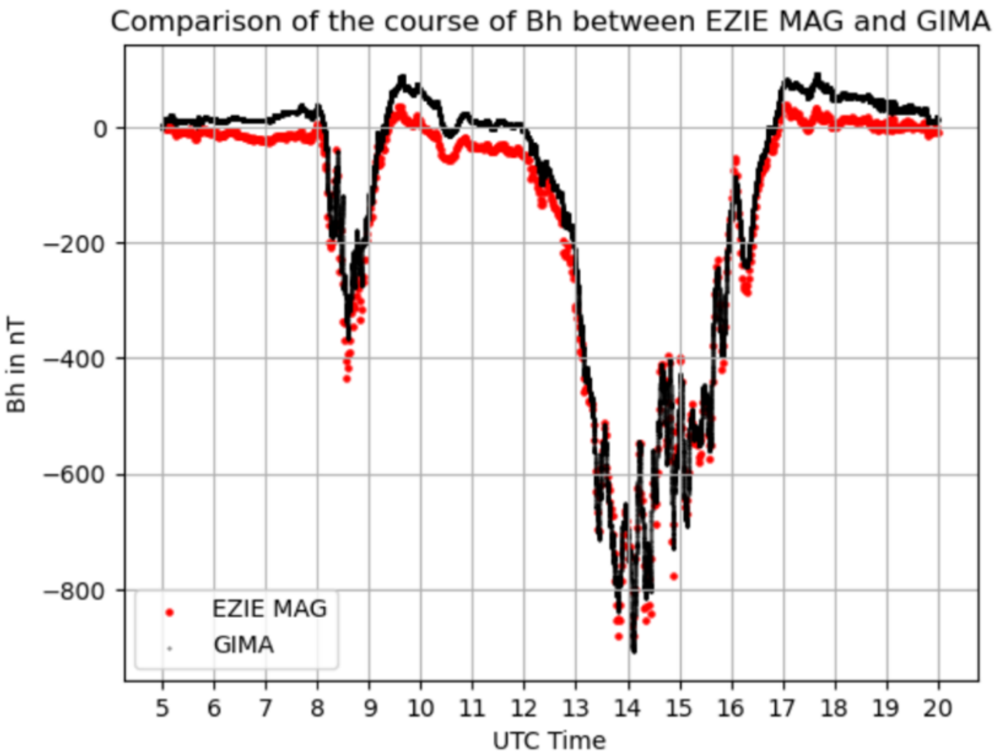
- $200 for complete sensor kit
- all open source
- will deploy 700 this summer (so far ~50)







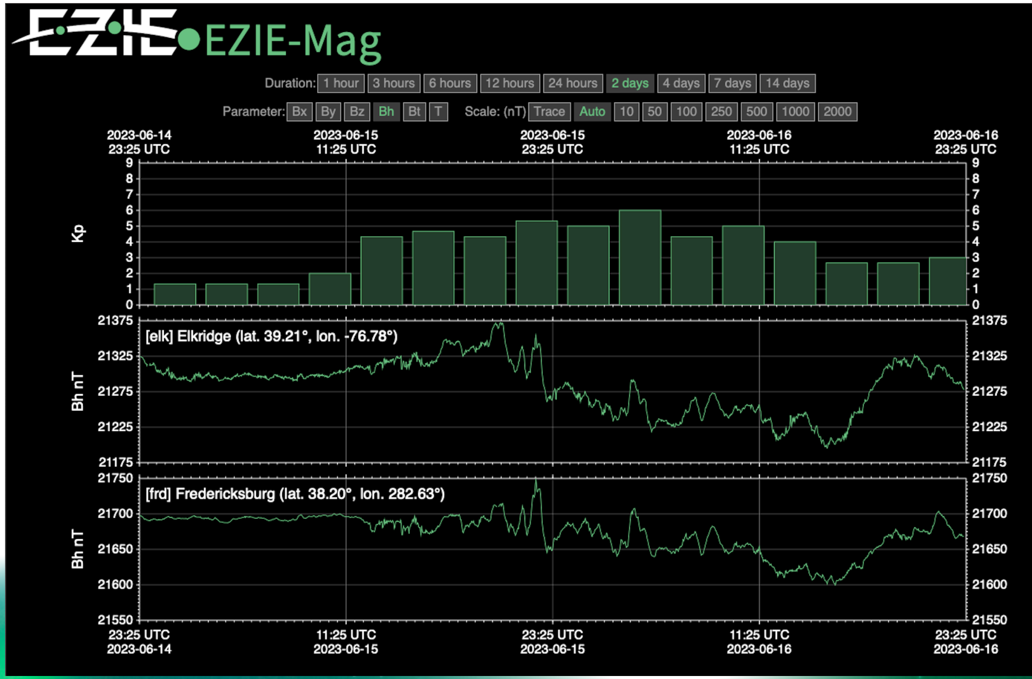
Pi Zero WH	Raspberry Pi Zero single-board computer with Wi-Fi and PIO pin header
RM3100 Sensor	PNI RM3100 three-axis magnetometer sensor with I2C interface
GPS NEO-6M	GPS module with serial interface
MCP9808	High-accuracy I2C temperature sensor
GY-521 MPU-6050	Three-axis gyroscope and three-axis accelerometer
Perf Board	PCB prototyping perf board
DuPont Wires	DuPont jumper wires
PCB Header Pins	Breakaway PCB header pins
Case	Pelican weatherproof case
64-Gb Micro-SD Card	64-Gb high-endurance memory card
Power coord	30′ micro USB cable



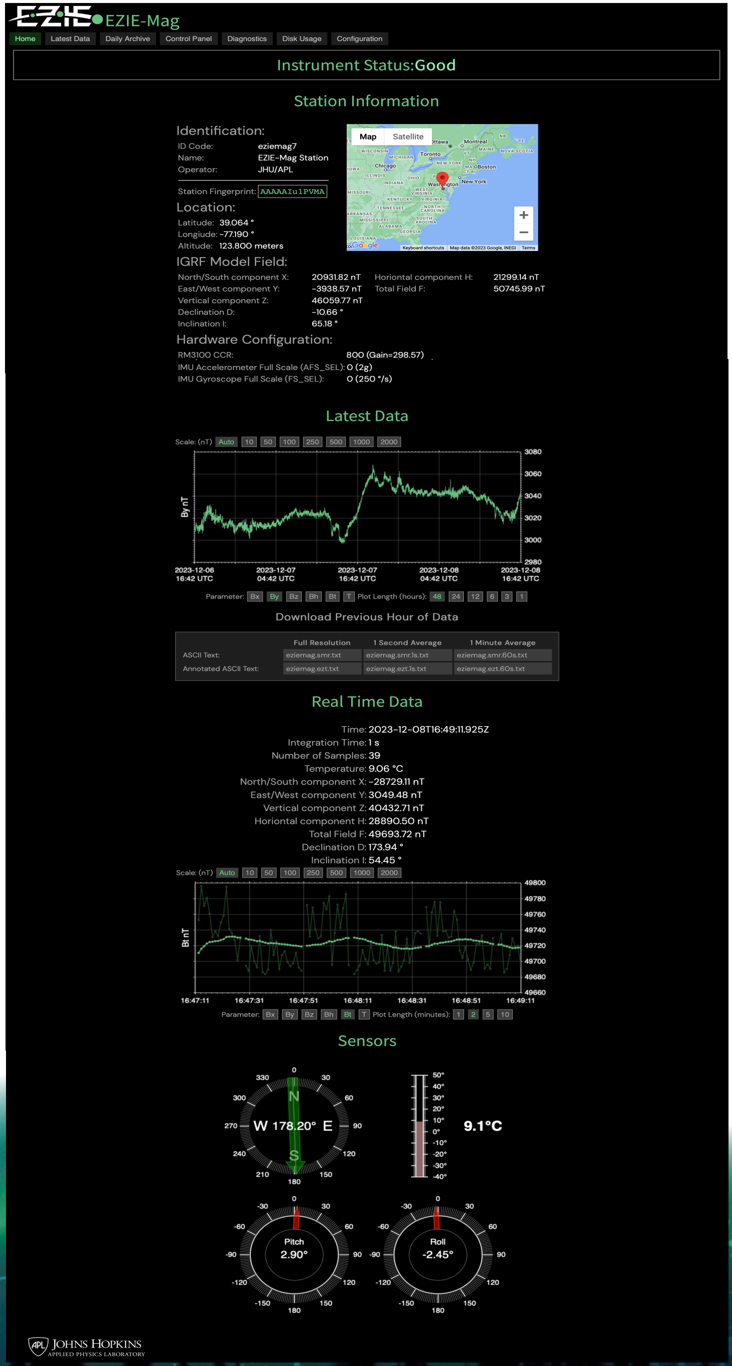
1-sigma noise at 1 sec resolution:
Full field: 6.1 nT (with wifi)
Full field: 3.6 nT (without wifi)

1-sigma noise at 1 min resolution:
Full field: 0.85 nT (with wifi)
Full field: 0.51 nT (without wifi)

Running at ~36 Hz.


EZIE-Mag
Duration: 1 hour 3 hours 6 hours 12 hours 24 hours 2 days 4 days 7 days 14 days
Parameter: Bx By Bz Bh Bt T
Scale: (nT) Trace Auto 10 50 100 250 500 1000 2000
2023-06-14 23:25 UTC
2023-06-15 11:25 UTC
2023-06-15 23:25 UTC
2023-06-16 11:25 UTC
2023-06-16 23:25 UTC
Kp
[elk] Elkridge (lat. 39.21°, lon. -76.78°)
Bh nT
21375
21325
21275
21225
21175
[frd] Fredericksburg (lat. 38.20°, lon. 282.63°)
Bh nT
21750
21700
21650
21600
21550

Acknowledging:
Jan Erik Fitzner, University of Alaska Fairbanks/University of Tübingen
Austin Cohen, University of Alaska Fairbanks
Dogacan Ozturk, University of Alaska Fairbanks


EZIE-Mag
Home
Latest Data
Daily Archive
Control Panel
Diagnostics
Disk Usage
Configuration
Map
Satellite
Keyboard shortcuts
Map data ©2023 Google, INEGI
Terms

Instrument Status:Good

Station Information

Identification:

ID Code: eziemag7
Name: EZIE-Mag Station
Operator: JHU/APL

Station Fingerprint: AAAAAIu1PVMA

Location:

Latitude: 39.064 °
Longiude: -77.190 °
Altitude: 123.800 meters

IGRF Model Field:

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East/West component Y: -3938.57 nT
Vertical component Z: 46059.77 nT
Declination D: -10.66 °
Inclination I: 65.18 °
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Latest Data

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By nT
3080
3060
3040
3020
3000
2980
2023-12-06 16:42 UTC
2023-12-07 04:42 UTC
2023-12-07 16:42 UTC
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Download Previous Hour of Data

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ASCII Text:	eziemag.smr.txt	eziemag.smr.1s.txt	eziemag.smr.60s.txt
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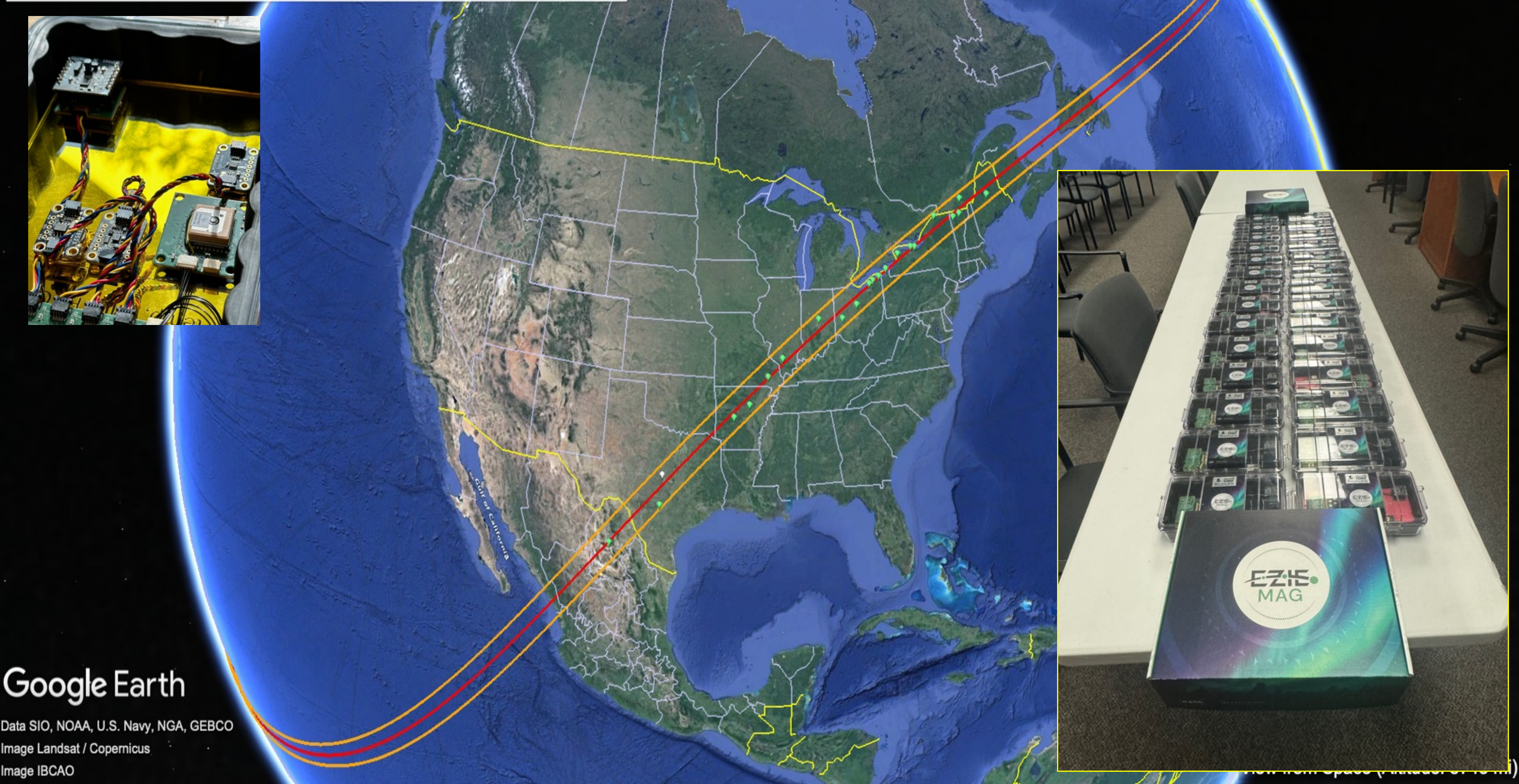
Horiontal component H: 28890.50 nT
Total Field F: 49693.72 nT
Declination D: 173.94 °
Inclination I: 54.45 °

Scale: (nT) Auto 10 50 100 250 500 1000 2000
Bt nT
49800
49780
49760
49740
49720
49700
49680
49660
16:47:11
16:47:31
16:47:51
16:48:11
16:48:31
16:48:51
16:49:11
Parameter: Bx By Bz Bh Bt T Plot Length (minutes): 1 2 5 10

Sensors

W 178.20° E
N
S
9.1°C
Pitch 2.90°
Roll -2.45°
JOHNS HOPKINS APPLIED PHYSICS LABORATORY

2024 EZIE-Mag Eclipse Measurement Campaign


Gulf of California
EZIE MAG

Google Earth

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Image IBCAO

PELICAN 1060
Micro Case Series
PELICAN PRODUCTS, TORRANCE, CA USA
EZIE MAG